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Solidification of nitrate solutions with alkali-activated slag and slag–metakaolin cements

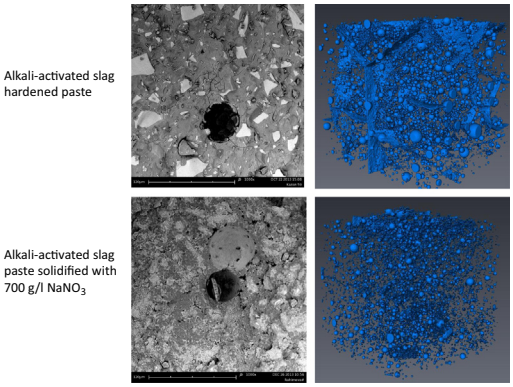
Nailia R. Rakhimova [a,*,1], Ravil Z. Rakhimov [a], Yury N. Osin [b], Natalia I. Naumkina [c], Alfiya M. Gubaidullina [c], Grigory I. Yakovlev [d], Arina V. Shaybadullina [d]

[a] Kazan State University of Architecture and Engineering, Kazan, Russian Federation
[b] Kazan Federal University, Kazan, Russian Federation
[c] Central Research Institute for Geology of Industrial Minerals, Kazan, Russian Federation
[d] Kalashnikov Izhevsk State Technical University, Izhevsk, Russian Federation

HIGHLIGHTS

- The effectiveness of an AASC matrix for $NaNO_3$ solution solidification is stated.
- XRD, DTA-TG, and X-ray microtomography experiments were performed.
- Crystallization of $NaNO_3$ reduces the shrinkage of hardened AASC-based waste forms.
- Metakaolin shortens the setting time and increases the compressive strength of AASC.

GRAPHICAL ABSTRACT



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ABSTRACT

The solidification of nitrate solutions with alkali-activated slag (AASC) and slag–metakaolin cements (AASMC) and the resulting setting times, compressive strengths, dimensional stability, water resistance, hydration products, microstructures, and macroporous network structures were evaluated. The influences of the alkali activator concentration, mineral composition of metakaolin, ratio of slag to slag + metakaolin, and concentration of $NaNO_3$ on the cement performance were all evaluated in detail. The compressive strength of cemented nitrate solutions with AASC and AASMC aged for 28 days was from 13.4 to 42 MPa depending on the $NaNO_3$ concentration. X-ray diffractometer, differential thermal analyzer, and electron microscope analyses suggested that $NaNO_3$ crystallizes in cementitious matrices without reacting with the hydration products of AASC and AASMC. X-ray microtomography showed that the solidified $NaNO_3$ solution with a salt concentration of 700 g/l and AASC had a denser microstructure without shrinkage microcracks, a smaller macropore volume, and smaller macropore sizes than hardened AASC-based paste mixed with water.

1. Introduction

There is a wide variety of alternative or non-traditional cements that significantly differ from ordinary Portland cement (PC) and from each other in terms of their composition and type of the

* Corresponding author.
E-mail address: rahimova.07@list.ru (N.R. Rakhimova).
[1] Presenting author.

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